

LTC4040

Battery Charger and Backup Power Manager

DESCRIPTION

Demonstration circuit 2118B is a combination step-down battery charger and step-up battery backup regulator using the LTC®4040 monolithic system power manager. The DC2118B has an input voltage range from 4.8V to 5.5V with overvoltage protection (OVP) to 40V, as limited by the external MOSFET. The input current is monitored to prioritize the load up to the 2.5A threshold before charge current is reduced.

Battery Charging

As initially configured, DC2118B is programmed for 2A charge current limit when in charge mode. The charge voltage is jumper-selectable in 8 discrete steps from 3.45V to 3.6V for LiFePO₄ chemistry or 3.95V to 4.1V for Li-ion chemistry, according to the F2/F1/F0 programming input settings.

The charge current limit is adjustable via the PROG pin resistor. End-of-charge status is triggered by current falling below C/8 and indicated by the CHRG LED. The

optional NTC input provides temperature fault detection and status indicated by the FAULT LED. Charging can be enabled/disabled with the ENCHG jumper.

Battery Backup

Following an input power failure, the circuit automatically shifts to battery backup boost mode to regulate the VSYS output rail. The backup mode system output voltage is initially programmed for 5V. The input power failure status is indicated by the PFO LED.

If VSYS ever falls below the programmed reset threshold voltage, the RST LED will change states to indicate the need to reset the system and recharge the battery. Backup regulation can be enabled/disabled with the ENBST jumper.

For convenience, all LEDs can be disabled with the LED jumper to reduce the quiescent current of the system.

Design files for this circuit board are available.

All registered trademarks and trademarks are the property of their respective owners.

PERFORMANCE SUMMARY

Specifications are at $T_A = 25^\circ\text{C}$

PARAMETER	CONDITIONS	VALUE
Charge Mode		
Input Voltage Range		4.8V to 5.5V
Overvoltage Protection Range	Limited by Q1 BV _{DSS}	5.5V to 40V
Input Current Limit	R7 = 10mΩ	2.5A
Default Charging Voltage	F2 = 1 (Li-Ion), F1 = 1, F0 = 1	4.10V
Charging Current	R _{PROG} = 1.00k	2.0A
Safety Timer Period	F2 = 1 (Li-Ion)	4Hr
	F2 = 0 (LiFePO ₄)	2Hr
Backup Mode		
DCIN Input Power Fail Threshold	R2 = 357k, R27 = 121k, DCIN Falling	4.8V
System Output Voltage	R4 = 1.69M, R5 = 324k	5.0V
Backup Battery Voltage Range		2.7V to 5.0V
System Reset Threshold	R4 = 1.69M, R5 = 324k, VSYS Falling	4.6V
Backup Boost Efficiency	V _{BAT} = 3.6V, I _{SYS} = 2A, V _{OUT} = 5V	89%

DEMO MANUAL DC2118B

PERFORMANCE SUMMARY

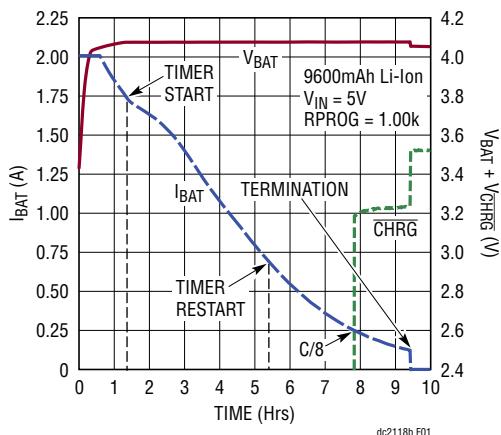


Figure 1. Typical Battery Charge Cycle

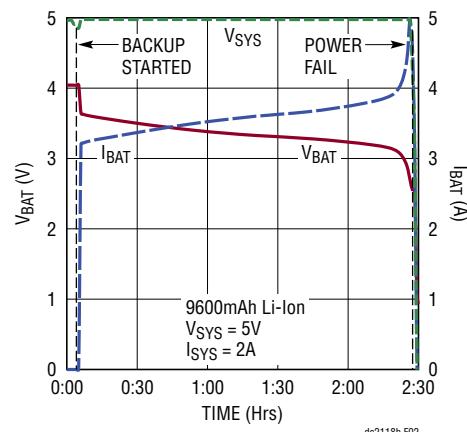


Figure 2. Typical Battery Discharge Cycle

QUICK START PROCEDURE

Demonstration circuit 2118B is easy to set up to evaluate the performance of LTC4040. Refer to Figure 2 for proper measurement equipment setup and follow the procedure below.

1. The jumpers are set as below for a typical 4.1V charging application:

JP1	NTC	INT
JP2	ENCHG	ON
JP3	ENBST	ON
JP4	F1	1
JP5	F0	1
JP6	LEDS	ON
JP7	F2	1

2. With all power off, connect the input supply, system load, and meters as shown in Figure 3.

Charge Mode

3. Connect the battery as shown in Figure 3 to charge at 4.1V, 2A. For alternate charge voltage settings, refer to Table 1.
4. Turn on the input power supply to evaluate charge mode. Adjust the input voltage and current limit to the desired value.

NOTE: While DC2118B is robust to overvoltage conditions up to 40V on DCIN, DO NOT exceed this limit or damage may occur to MOSFET Q1 and IC U1.

5. Turn on and adjust the system load as necessary. Charging current will be limited when input current exceeds 2.5A.
6. The CHRG LED will toggle off when the charge current has dropped below 250mA. The timer will continue to run and charging will continue until the timer period ends. Multiple timer periods may be necessary to fully charge a large capacity battery, such as the one used to obtain Figure 1.
7. If the battery voltage does not increase above the low battery threshold during the precondition time or the thermistor value exceeds the normal range, CHRG will toggle off and FAULT will toggle on indicating a bad battery.

Backup Mode

8. Turn off the input power supply to evaluate backup mode.
9. The PFO LED will toggle on indicating input power failure.
10. Adjust the system load as necessary.

QUICK START PROCEDURE

11. Total backup runtime is based on battery capacity, circuit efficiency, and system load. Figure 2 shows an example discharge curve with constant current system load.
12. When VSYS falls below 7.5% of the programmed value, or 4.6V, then RST will toggle on.

Optional

1. Use an external thermistor connected between EXTNTC and GND as shown in Figure 3, with the NTC jumper, JP1, set to EXT.
2. Change the setting of the ENCHG, JP2, or ENBST, JP3, jumpers to enable/disable charging and backup boost respectively.
3. Monitor the PROG pin voltage for a scaled representation of the instantaneous charge current according to the relationship:

$$I_{BAT} = \frac{2000 \cdot V_{PROG}}{R_{PROG}}$$

Where $R_{PROG} = R6 = 1\text{k}\Omega$.

4. Monitor the CLPROG pin voltage for a scaled representation of the instantaneous total input current according to the relationship:

$$I_{VIN} = \frac{V_{CLPROG}}{32 \cdot R_S}$$

Where $R_S = R7 = 10\text{m}\Omega$.

5. All status LEDs can be disconnected to reduce the quiescent current by setting the LEDS jumper, JP6 to OFF.
6. External VDD can be used by connecting to EXTVDD and installing 0Ω for R16.

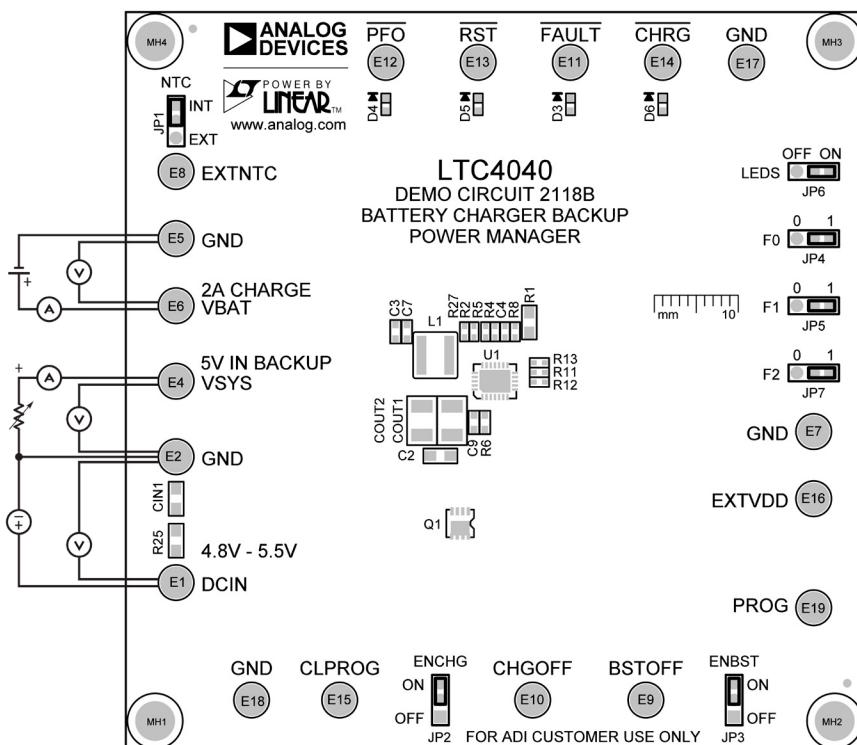


Figure 3. Proper Measurement Equipment Setup

Table 1. Battery Charge Voltage Jumper Settings

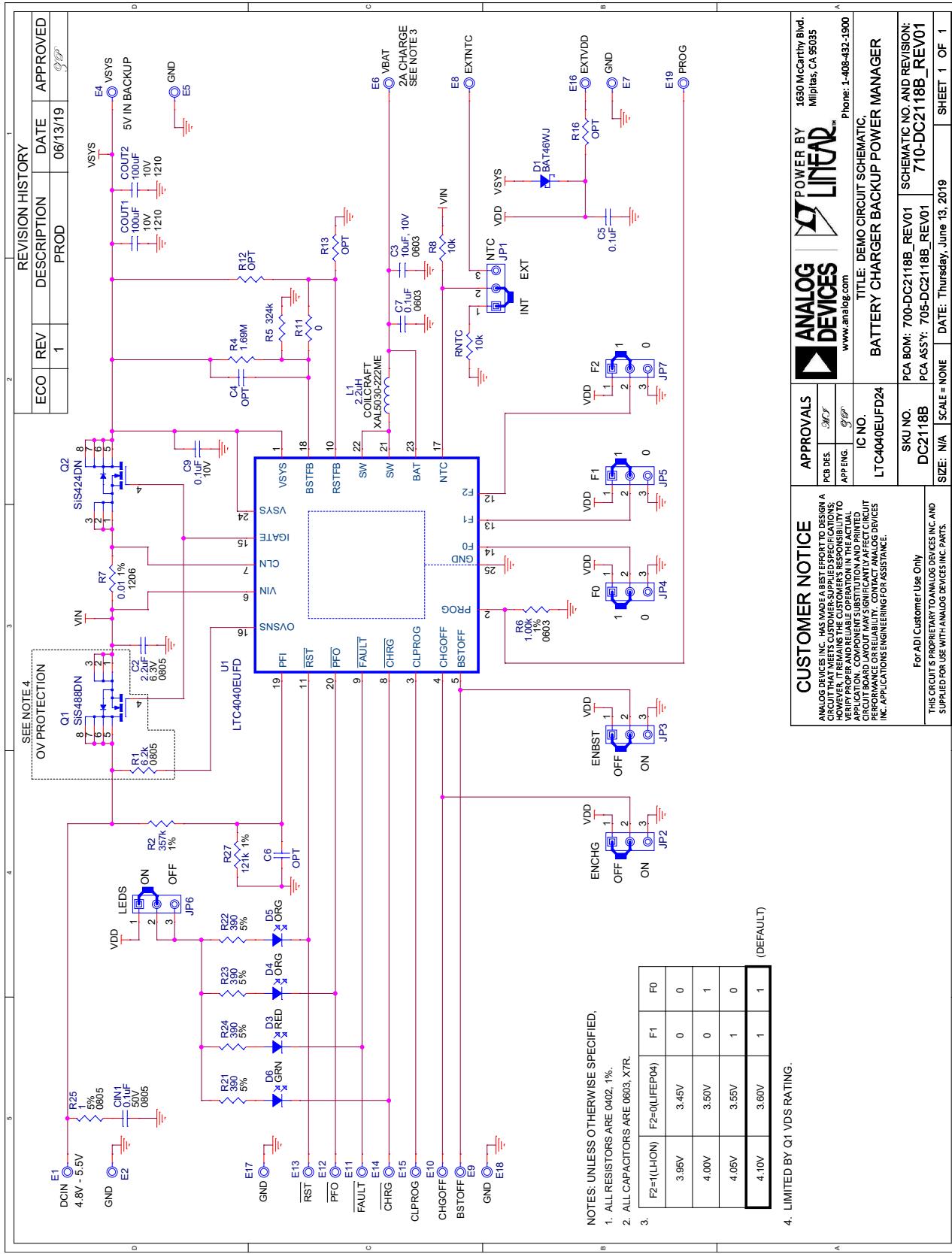
JP7		JP5	JP4
F2 = 1 (Li-Ion)	F2 = 0 (LiFePO ₄)	F1	F0
3.95	3.45	0	0
4.00	3.50	0	1
4.05	3.55	1	0
4.10	3.60	1	1

DEMO MANUAL DC2118B

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	CIN1	CAP, X7R, 0.1µF, 10%, 50V, 0805	AVX, 08055C104KAT4A
2	2	COUT1, COUT2	CAP, X5R, 100µF, 20%, 10V, 1210	MURATA, GRM32ER61A107ME20L
3	1	C2	CAP, X7R, 2.2µF, 10%, 6.3V, 0805	MURATA, GRM21BR70J225MA01L
4	1	C3	CAP, X5R, 10µF, 20%, 10V, 0603	AVX, 0603ZD106MAT2A
5	2	C7, C9	CAP, X7R, 0.1µF, 10%, 10V, 0603	AVX, 0603ZC104KA72
6	1	L1	INDUCTOR, 2.2µH	COILCRAFT, XAL5030-222ME
7	1	Q2	XSTR, MOSFET N-CHANNEL, 20-V	VISHAY, SiS424DN-T1-GE3
8	1	R2	RES., 357k, 1/16W, 1%, 0402	VISHAY, CRCW0402357KFKED
9	1	R4	RES., 1.69MΩ, 1/16W, 1%, 0402	VISHAY, CRCW04021M69FKED
10	1	R5	RES., 324k, 1/16W, 1%, 0402	VISHAY, CRCW0402324KFKED
11	1	R6	RES., 1.00k, 1/10W, 1%, 0603	VISHAY, CRCW06031K00FKED
12	1	R7	RES., 0.01Ω, 1/4W, 1%, 1206	VISHAY, WSL1206R0100FEB
13	1	R8	RES., 10k, 1/16W, 1%, 0402	VISHAY, CRCW040210K0FKED
14	1	R11	RES., 0Ω JUMPER, 0402	VISHAY, CRCW04020000Z0ED
15	1	R25	RES., 1Ω, 1/8W, 5%, 0805	VISHAY, CRCW0805100RJNEA
16	1	R27	RES., 121k, 1/16W, 1%, 0402	VISHAY, CRCW0402121KFKED
17	1	U1	I.C., LTC4040EUF	ANALOG DEVICES, LTC4040EUF#PBF
Additional Demo Board Circuit Components				
1	0	C4, C6	CAP, 0402	OPT
2	1	C5	CAP, X5R, 0.1µF, 10%, 10V, 0402	MURATA, GRM155R71A104KA01J
3	1	D1	DIODE, SCHOTTKY	NXP, BAT46WJ
4	1	D3	DIODE, LED, SMT, RED, 0603	LITE-ON, LTST-C193KRKT-5A
5	2	D4, D5	DIODE, LED, SMT, ORANGE, 0603	LITE-ON, LTST-C193KFKT-5A
6	1	D6	DIODE, LED, SMT, GREEN, 0603	LITE-ON, LTST-C193KGKT-5A
7	1	Q1	XSTR, MOSFET N-CHANNEL, 40-V	VISHAY, SiS488DN-T1-GE3
8	1	RNTC	RES., 10k, 1/16W, 1%, 0402	VISHAY, CRCW040210K0FKED
9	1	R1	RES., 6.2k, 1/8W, 5%, 0805	VISHAY, CRCW08056K20JNEA
10	0	R12, R13, R16	RES., 0402	OPT
11	4	R21-R24	RES., 390Ω, 1/16W, 5%, 0402	VISHAY, CRCW0402390RJNED
Hardware: For Demo Board Only				
1	18	E1, E2, E4-E19	TEST POINT, TURRET, 0.094"	MILL-MAX, 2501-2-00-80-00-00-07-0
2	7	JP1-JP7	3 PIN JUMPER, 2mm	SAMTEC TMM-103-02-L-S
3	7	XJP1-XJP7	SHUNT, 2mm	SAMTEC 2SN-BK-G
4	4	STAND-OFF	STAND-OFF, NYLON	KEYSTONE, 8834(SNAP ON)

SCHEMATIC DIAGRAM



Information furnished by Analog Devices is believed to be accurate and reliable. However, no responsibility is assumed by Analog Devices for its use, nor for any infringements of patents or other rights of third parties that may result from its use. Specifications subject to change without notice. No license is granted by implication or otherwise under any patent or patent rights of Analog Devices.

DEMO MANUAL DC2118B



ESD Caution

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

Legal Terms and Conditions

By using the evaluation board discussed herein (together with any tools, components documentation or support materials, the "Evaluation Board"), you are agreeing to be bound by the terms and conditions set forth below ("Agreement") unless you have purchased the Evaluation Board, in which case the Analog Devices Standard Terms and Conditions of Sale shall govern. Do not use the Evaluation Board until you have read and agreed to the Agreement. Your use of the Evaluation Board shall signify your acceptance of the Agreement. This Agreement is made by and between you ("Customer") and Analog Devices, Inc. ("ADI"), with its principal place of business at One Technology Way, Norwood, MA 02062, USA. Subject to the terms and conditions of the Agreement, ADI hereby grants to Customer a free, limited, personal, temporary, non-exclusive, non-sublicensable, non-transferable license to use the Evaluation Board FOR EVALUATION PURPOSES ONLY. Customer understands and agrees that the Evaluation Board is provided for the sole and exclusive purpose referenced above, and agrees not to use the Evaluation Board for any other purpose. Furthermore, the license granted is expressly made subject to the following additional limitations: Customer shall not (i) rent, lease, display, sell, transfer, assign, sublicense, or distribute the Evaluation Board; and (ii) permit any Third Party to access the Evaluation Board. As used herein, the term "Third Party" includes any entity other than ADI, Customer, their employees, affiliates and in-house consultants. The Evaluation Board is NOT sold to Customer; all rights not expressly granted herein, including ownership of the Evaluation Board, are reserved by ADI. CONFIDENTIALITY. This Agreement and the Evaluation Board shall all be considered the confidential and proprietary information of ADI. Customer may not disclose or transfer any portion of the Evaluation Board to any other party for any reason. Upon discontinuation of use of the Evaluation Board or termination of this Agreement, Customer agrees to promptly return the Evaluation Board to ADI. ADDITIONAL RESTRICTIONS. Customer may not disassemble, decompile or reverse engineer chips on the Evaluation Board. Customer shall inform ADI of any occurred damages or any modifications or alterations it makes to the Evaluation Board, including but not limited to soldering or any other activity that affects the material content of the Evaluation Board. Modifications to the Evaluation Board must comply with applicable law, including but not limited to the RoHS Directive. TERMINATION. ADI may terminate this Agreement at any time upon giving written notice to Customer. Customer agrees to return to ADI the Evaluation Board at that time. LIMITATION OF LIABILITY. THE EVALUATION BOARD PROVIDED HEREUNDER IS PROVIDED "AS IS" AND ADI MAKES NO WARRANTIES OR REPRESENTATIONS OF ANY KIND WITH RESPECT TO IT. ADI SPECIFICALLY DISCLAIMS ANY REPRESENTATIONS, ENDORSEMENTS, GUARANTEES, OR WARRANTIES, EXPRESS OR IMPLIED, RELATED TO THE EVALUATION BOARD INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, TITLE, FITNESS FOR A PARTICULAR PURPOSE OR NONINFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. IN NO EVENT WILL ADI AND ITS LICENSORS BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES RESULTING FROM CUSTOMER'S POSSESSION OR USE OF THE EVALUATION BOARD, INCLUDING BUT NOT LIMITED TO LOST PROFITS, DELAY COSTS, LABOR COSTS OR LOSS OF GOODWILL. ADI'S TOTAL LIABILITY FROM ANY AND ALL CAUSES SHALL BE LIMITED TO THE AMOUNT OF ONE HUNDRED US DOLLARS (\$100.00). EXPORT. Customer agrees that it will not directly or indirectly export the Evaluation Board to another country, and that it will comply with all applicable United States federal laws and regulations relating to exports. GOVERNING LAW. This Agreement shall be governed by and construed in accordance with the substantive laws of the Commonwealth of Massachusetts (excluding conflict of law rules). Any legal action regarding this Agreement will be heard in the state or federal courts having jurisdiction in Suffolk County, Massachusetts, and Customer hereby submits to the personal jurisdiction and venue of such courts. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this Agreement and is expressly disclaimed.

Rev. 0